10/526989

Attorney Docket: 3926.135 Patent Application

DT01 Rec'd PCT/PTC 07 MAR 2005

METHOD FOR THE LASER MACHINING OF COATED SHEETS

BACKGROUND OF THE INVENTION

Field of the invention

[0002] The invention relates to a method for the laser machining of coated sheets, according to the preamble of patent claim 1. A method of this type is already known from DE 44 07 190 A1.

Related Art of the Invention

[0003] With many coated sheets, in particular zinc-coated sheets as used in the automobile industry, the coating material has a markedly lower boiling point than the melting point of the sheet material. When sheets of this type are laser-welded in a lap joint, this leads to explosive vaporizations of coating material, which seriously affect the quality of the joint.

[0004] In order to improve the joint quality, it has already been proposed to use spacers to create narrow gaps between the sheets, into which the vaporized coating material can escape. Suitable crater-shaped spacers can be generated, according to JP 11-047967, by laser bombardment of the surface. According to DE 44 07 190 A1, knurling-type spacers can be produced by means of a laser scanner device.

[0005] The primary drawback in this is the relatively long time necessary for the machining, which, especially in mass production, creates considerable costs.

SUMMARY OF THE INVENTION

[0006] The object of the present invention therefore consists in lowering the machining time necessary for the production of spacers, whilst at least maintaining, preferably improving, the quality of the machining.

[0007] The invention is depicted, in relation to the method to be provided, by the features of patent claim 1. The further claims contain advantageous embodiments and refinements of the method according to the invention (patent claims 2 to 6).

[0008] In respect of the method to be provided, the object is achieved according to the invention by the fact that the laser beam is directed onto the surface by means of a scanner device. A scanner device is a particularly fast and flexible steel-deflecting device, for example a mirror system (consisting of at least one pivotable mirror which can be driven on a single-axis or multi-axis basis), or else acousto-optical modulators.

[0009] The great advantage of the method according to the invention over that which is proposed in JP 11-047967 consists in the fact that the scanner device is moved evenly relative to the surface of a sheet and, at the same time, the scanner device directs the laser beam onto one machining area for a brief machining period and then very quickly redirects it to another machining area. The times which are necessary for the repositioning of the laser beam are thereby almost fully eliminated, allowing the laser system to be put to very effective use.

[00010] Contrastingly, in a conventional laser system, as is used, for example, in JP 11-047967, a laser beam is directed onto the machining area by means of a rigid lens system. For transfer to a second machining area, the lens system has to be moved relative to the structural element, during which time the laser must be switched off. According to the invention, furthermore, the position and arrangement of the topographical changes are

freely programmable within the working range of the laser scanner. In comparison with the rigid lens system, the laser scanner does not have to be positioned over the individual topographical changes, but can advantageously be guided on an optimized path between the topographical changes. These differences result in very different necessary machining times: using a laser scanner, it is possible to generate 30 suitable topographical changes in about 0.3 seconds; a conventional system requires about 10 times the machining time.

[00011] In one advantageous embodiment of the method according to the invention, the laser beam is not focused upon the surface. Preferably the focus is situated at such a distance from the surface of the sheet to be machined that the irradiation area of the laser on the surface exceeds the focal area thereof by at least 50 percent, preferably 200 percent. The entire machining area is covered by moving the irradiation area by means of minimal redirection of the laser beam. Such areal warming standardizes the fusion or melting process for coating and sheet and promotes the formation of suitable topographical changes.

[00012] In a further advantageous embodiment of the method according to the invention, the laser beam generates the at least one topographical change on that side of the at least one sheet which faces away from said beam, by continuously fusing or melting this sheet in the region of its machining area. To this end, a suitable machining or processing time up to the point of penetration shall be pre-specified, or else a penetration sensor provided which regulates the machining time. This embodiment allows the method to be further speeded up if a plurality of sheets are welded together. In the method according to JP 11-047967, a single sheet is firstly aligned and then topographical

changes are made to this sheet, whereafter a further sheet is supplied and aligned relative to the first and then the two are pressed together and welded together. It is more advantageous, however, to align the two sheets jointly without contact pressure. In the absence of contact pressure, a minimal gap, which is sufficient for most applications, remains between the sheets, though it can also be assured by means of a suitable aligning apparatus. After this, topographical changes according to this advantageous embodiment of the inventive method are introduced through one, or even both of the sheets. Next, the sheets are pressed together and welded together. In view of the high speed of the scanner device and the generation of the topographical changes, the saving of one alignment process implies a very substantial time saving.

[00013] It is also advantageous if the laser beam is guided by the scanner device in such a way that it describes about the center of its machining area a narrowing spiral. This allows, especially in the case of shoot-through machining, more even fusion or melting and cooling processes and thus the formation of a topographical change in the form of an evenly contoured elevation.

[00014] In a further advantageous embodiment of the method according to the invention, at least one further sheet is brought into contact with the at least one coated sheet in such a way that the at least one protruding topographical change causes the formation of at least one gap between the at least two sheets, and that the at least two sheets, in the region of the at least one gap, are welded together in such a way that vaporization products formed in the process can escape into the at least one

gap. The escape facility for the vaporization products ensures a substantially higher quality of weld seam.

[00015] In another advantageous embodiment of the method according to the invention, the at least two sheets are welded together in such a way that the resultant weld seam at least partially overlays the at least one topographical change previously generated.

[00016] Each such topographical change constitutes an injury to the coating, since this, due to the laser irradiation, vaporizes, leaving behind the bare sheet material. In automobile construction, a zinc coating, in particular, is used as corrosion protection. Any injury can constitute a seed for future corrosion. Although a weld seam also constitutes such an injury, it is vital to the joint. The fact that the weld seam is drawn over the topographical changes and at least partially replaces them means that the number of possible corrosion seeds is reduced and hence the corrosion risk diminished. For a subsequent anti-corrosion treatment, especially galvanization, the shape of the topographical changes is crucial: According to the invention, an evenly contoured mountain is formed, according to JP 11-047967 a crater is formed. A mountain has a smaller surface than a crater formed from the same quantity of material, and thus a smaller area of attack from corrosion. In addition, a mountain can also be galvanized all the way round between two sheets, whereas a crater is covered by the above-lying sheet and cannot be galvanized on the inside. Moisture can get inside the crater as the sheets are joined together, and the topographical change becomes the corrosion seed.

Detailed Description of the Invention

[00017] The method according to the invention is explained in greater detail below with reference to two illustrative embodiments:

[00018] In a first illustrative embodiment, a coated sheet is aligned, a scanner device is moved evenly over it and directs a laser beam onto a plurality of machining areas one after the other. The scanner device consists of a computer-controlled mirror system which is pivotable in two dimensions. The scanner device has approx. 320 mm distance to the surface of the sheet, the laser focus is situated about 20 mm before the surface. The defocusing of the laser beam produces an areal and even warming of the machining area. This results in a more even vaporization of the coating and the formation of a topographical change in the form of an evenly contoured mountain. Following generation of the required number of topographical changes, a second sheet is supplied and aligned, whereafter the two are pressed together and welded together.

[00019] In a second illustrative embodiment, two coated sheets are aligned one above the other at a distance apart. A scanner device is moved evenly over them and directs a laser beam onto a plurality of machining areas one after the other. The scanner device consists of a computer-controlled mirror system which is pivotable in two dimensions. The scanner device has approx. 305 mm distance to the surface of a sheet, the laser focus is situated about 4-7 mm before the surface. The laser beam is guided by the scanner device in such a way that it describes about the center of its machining area a narrowing spiral. The defocusing of the laser beam produces an areal and even warming of the machining area. As a result of the spiral movement from

outer to inner, a more even formation of the topographical change on that side of the sheet facing away from the laser is realized, in the form of an evenly contoured mountain. Following generation of the required number of topographical changes, the two sheets are pressed together and welded together. The weld seam is herein guided at least over some of the topographical changes.

[00020] In the embodiments of the examples described above, the method according to the invention proves especially suitable for the laser-welding of coated sheets in the automobile industry.

[00021] In particular, considerable advantages in terms of the machining time can thus be obtained. Yet the corrosion protection can also be enhanced by the improved shape of the topographical changes and by the guidance of the weld seam over at least a part of the topographical changes.

[00022] The invention is not limited to the illustrative embodiments previously portrayed, but can rather be transferred to other ones as well.

[00023] It is thus conceivable, for instance, to form the scanner device, instead of by a mirror system, by acousto-optical modulators. It is further possible, instead of guiding the laser scanner over the surface of the structural element, to move the structural elements beneath a fixed scanner. Where appropriate, scanner and structural element can perform a mutually coordinated movement.

[00024] The distance of the scanner device from the sheet and the degree of defocusing are also non-critical and can be matched, where necessary, to the laser output for example, or

even to the sheet and/or coating material. In addition, it may be advantageous to suitably vary the laser output during the irradiation.